INDOOR AIR QUALITY ASSESSMENT

Henry Lord Middle School
151 Amity Street
Fall River, MA 02721

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
February 2006

Background/Introduction

At the request of the Massachusetts Department of Public Health's (MDPH), Center for Health Information, Statistics and Research, Occupational Health Surveillance Program, the MDPH's Center for Environmental Health (CEH) conducted an indoor air quality assessment at the Henry Lord Middle School (LMS) located at 151 Amity Street, Fall River, Massachusetts. The assessment was prompted by a reported case of occupational asthma. The MDPH statewide surveillance system for work-related asthma was initiated in 1992, when the MDPH passed regulations requiring physicians to report cases of occupational asthma.

On November 30, 2005, a visit to conduct an assessment at the LMS was made by Cory Holmes, Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Holmes was accompanied by Michael Coughlin, Director of Health and Human Services for the City of Fall River, for portions of the assessment.

The school is a two-story red brick building constructed in 1991. The first floor contains general classrooms, science classrooms, kitchen, cafeteria, library, gymnasium, locker rooms, art rooms, computer rooms and office space. The second floor is made up of general and science classrooms.

A previous visit to conduct air testing for mold was made in September of 2005 by Environmental Enterprises & Associates, Inc. (EEI), an environmental engineering firm. The EEI report described water damaged/mold colonized wallboard in several classrooms resulting from water intrusion; most likely through exterior air intake grates during heavy rain (EEI, 2005). The breaches around univent air intakes were reportedly sealed and remediation of water damaged building materials (e.g., removal of wallboard and insulation) and mold abatement was completed on September 23, 2005. Post-abatement mold sampling was conducted on September 26, 2005. EEI concluded that mold abatement activities were effective; sampling results yielded no elevated levels of mold spores in affected classrooms (EEI, 2005).

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID). CEH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The school houses approximately 715 students in grades 6-8 and a staff of approximately 75. Tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million parts (ppm) in seventeen of thirty-seven areas surveyed, indicating inadequate air exchange in these areas. This observation was likely associated with mechanical ventilation components being deactivated.

Fresh air in each classroom is supplied by a computer-controlled unit ventilator (univent) system (Picture 1). A univent draws air from outdoors through a fresh air intake located on the exterior wall of the building (Picture 2) and returns air through an air intake located at the base of the unit (Figure 1). Fresh and return air are mixed, filtered, heated or cooled and provided to classrooms through an air diffuser located in the top of the unit. Adjustable louvers control the ratio of fresh outdoor air to recirculated air. Univents have a control switch for settings of off, low or high (Picture 3). Some classrooms have univents installed above the ceiling that are ducted to classrooms via multi-directional air diffusers (Picture 4). Univents that had been deactivated were found in a number of areas (Table 1). Obstructions to airflow, such as items stored on or in front of univents were seen in some areas (Pictures 1 and 5). In order for univents to provide fresh air as designed, units must be activated while rooms are occupied and air diffusers should remain free of obstructions.

The mechanical exhaust ventilation system consists of ceiling-mounted exhaust vents (Picture 6) ducted to rooftop motors. Exhaust vents were not functioning in the portion of the building that contains rooms 201-205. Without sufficient supply and exhaust ventilation, environmental pollutants can build up and lead to indoor air quality/comfort complaints.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems reportedly occurred prior to occupancy in 1992.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that a room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix A of this assessment.

Temperature measurements ranged from 67^{o} F to 75^{o} F, which were within or below the MDPH recommended comfort guidelines. The MDPH recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity ranged from 57 to 69 percent, which was above the MDPH recommended comfort range in several areas during the assessment. The MDPH recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. While temperature is mainly a comfort issue, relative humidity in excess of 70 percent for extended periods of time can provide an environment for mold and fungal growth (ASHRAE, 1989). During the heating season, relative humidity levels would be expected to drop below the recommended comfort range. The sensation of dryness and irritation is common in a low relative humidity environment. For buildings in New England, periods of low relative humidity during the winter are often unavoidable.

Microbial/Moisture Concerns

The building has reportedly had chronic problems with water damage in the section of the building housing classrooms 143 and 145. Water intrusion had reportedly occurred around univent air intakes during heavy rains. These areas were reportedly sealed. No visible mold was observed during the MDPH assessment; however, historic water damage in this area is evidenced by rusted metal on ceiling tracks, univent covers and file cabinets and peeling paint (Pictures 7-10). A black gum-like substance observed on and around seams of floor tiles, which appears to be mastic from beneath the tiles, is also evidence of water damage (Pictures 11 and 12).

Although water infiltration may be a possible source of moisture impacting floor tiles, high indoor relative humidity during summer months also appears to be a likely source of moisture in the building. Potential sources for the introduction of humid outside air include opening windows and exterior doors while univents are operating in the air-conditioning setting. Introduction of uncontrolled hot, moist air in an air-conditioned building likely generates condensation on chilled surfaces. Over time, water droplets can form. The accumulation of condensation on a chilled surface would, in turn, moisten building materials. Condensation is the collection of moisture on a surface at or below the dew point. The dew point is the temperature that air must reach for saturation to occur. The dew point is a temperature determined by air temperature and relative humidity.

Several areas had water damaged ceiling tiles (Picture 13); a water stained lighting panel was observed in room 250-B (Picture 14). Such damage can indicate leaks from the roof or plumbing system. During the assessment, an active leak was observed in the boy's locker room (Picture 15). Water-damaged ceiling tiles and other porous building materials can provide a source of mold and should be replaced after a moisture source or leak is discovered and repaired.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (ACGIH, 1989; US EPA, 2001). If porous materials are not dried within this time frame, mold growth may occur. Cleaning cannot adequately remove mold growth from water-damaged porous materials. The application of a mildewcide to moldy porous materials (e.g., ceiling tiles) is not recommended.

Plants were noted in several classrooms and in close proximity to univent air intakes and diffusers (Picture 16). Plants can be a source of pollen and mold, which can be respiratory irritants for some individuals. Plants should be properly maintained and equipped with drip pans. Plants should also be located away from ventilation sources to prevent the entrainment and/or aerosolization of dirt, pollen or mold.

Other IAQ Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, MDPH staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels.

On the day of assessment, outdoor carbon monoxide concentrations were non-detect (ND). Carbon monoxide levels measured in the school were also ND (Table 1).

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 microgram per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2000a). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective proposed PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 20 $\mu g/m^3$ (Table 1). PM2.5 levels measured in the school ranged from 6 to 20 $\mu g/m^3$, which were below the NAAQS of 65 $\mu g/m^3$ (Table 1). Frequently, indoor air levels of particulates can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulates during normal operation. Sources of indoor airborne particulate may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices, operating an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be negatively influenced by the presence of materials containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Indoor TVOC concentrations were ND (Table 1). An outdoor air sample was taken for comparison. Outdoor TVOC concentrations were also ND.

Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. In an effort to identify materials that can potentially increase indoor TVOC concentrations, MDPH staff examined classrooms for products containing these respiratory irritants. Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat. Cleaning products were also found on countertops and in unlocked cabinets beneath sinks in some classrooms. Like dry erase materials, cleaning products contain VOCs and other chemicals that can be irritating to the eyes, nose and throat of sensitive individuals.

Plug-in air fresheners/deodorizers were in use in some classrooms (Picture 17). These products contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Furthermore, air fresheners do not remove materials causing odors, but rather mask odors that may be present in the area.

Finally, a number of classroom supply and exhaust vents were noted with accumulated dust (Pictures 4 and 18). If not operating, back drafting may occur, resulting in re-aerosolization of accumulated dust particles. Dust can be irritating to the eyes, nose and respiratory tract. Vents should also be cleaned periodically to prevent dust accumulation on louvers.

Conclusions/Recommendations

Previous environmental assessments conducted at the LES demonstrated that moisture problems and mold contamination did exist during the Fall of 2005. The current assessment indicates continued moisture problems in some areas of the school that the Fall River School Department should continue to address. In view of the findings at the time of the assessment, the following recommendations are made:

1. Continue to monitor breaches in the building envelope (e.g., around univent air intakes) to ensure they are sealed to prevent further water penetration.
2. Ensure windows closed during hot, humid weather to maintain indoor temperatures and to avoid condensation problems.
3. Consider removing several tiles in areas of chronic water damage (classrooms 143 and 145) to determine if visible moisture and/or microbial growth are present. If so, the removal of all affected tiles followed by cleaning with an appropriate antimicrobial agent may be necessary.

4. Consider contacting a reputable flooring contractor to remove/replace old tiles and mastic. Slab should be completely cleaned and sealed with a proper sealant and/or vapor barrier.
5. Consider contacting a building engineer for an examination of possible moisture remediation/prevention strategies if moisture accumulation/damage to floor tiles in the building recurs.
6. Operate all ventilation systems throughout the building (e.g., gym, cafeteria, classrooms) continuously during periods of school occupancy and independent of thermostat control. To increase airflow in classrooms, set univent controls to "high".
7. Inspect exhaust motors and belts for proper function. Repair and replace as necessary.
8. Remove all blockages from univents to ensure adequate airflow.
9. Close classroom doors to maximize air exchange.
10. Consider adopting a balancing schedule of every 5 years for mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
11. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help

ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).

12. Continue with plans to repair roof leak in boy's locker room.

13. Replace water-damaged ceiling tiles. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.

14. Move plants away from univents in classrooms. Ensure all plants are equipped with drip pans. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.

15. Store cleaning products properly and out of reach of students.

16. Refrain from using strongly scented items, such as plug-in air deodorizers.

17. Clean univent air diffusers and exhaust vents periodically of accumulated dust.

18. Consider adopting the US EPA (2000b) document, "Tools for Schools", to maintain a good indoor air quality environment on the building. This document can be downloaded from the Internet at: http://www.epa.gov/iaq/schools/index.html.

19. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website: http://mass.gov/dph/indoor_air.

References

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Picture 1

Classroom Univent, Note Storage of Materials on Air Diffuser

Picture 2

Univent Outside Air Intake

Picture 3

Univent Control Switch Set to the off Position in Classroom

Picture 4

Multi-Directional Air Diffuser for Ceiling-Mounted Univent, Note Dust/Dirt Accumulation on Diffuser and on Adjacent Ceiling Tiles

Picture 5

Univent Return Vent (Bottom Front of Unit) Obstructed by Bookcase

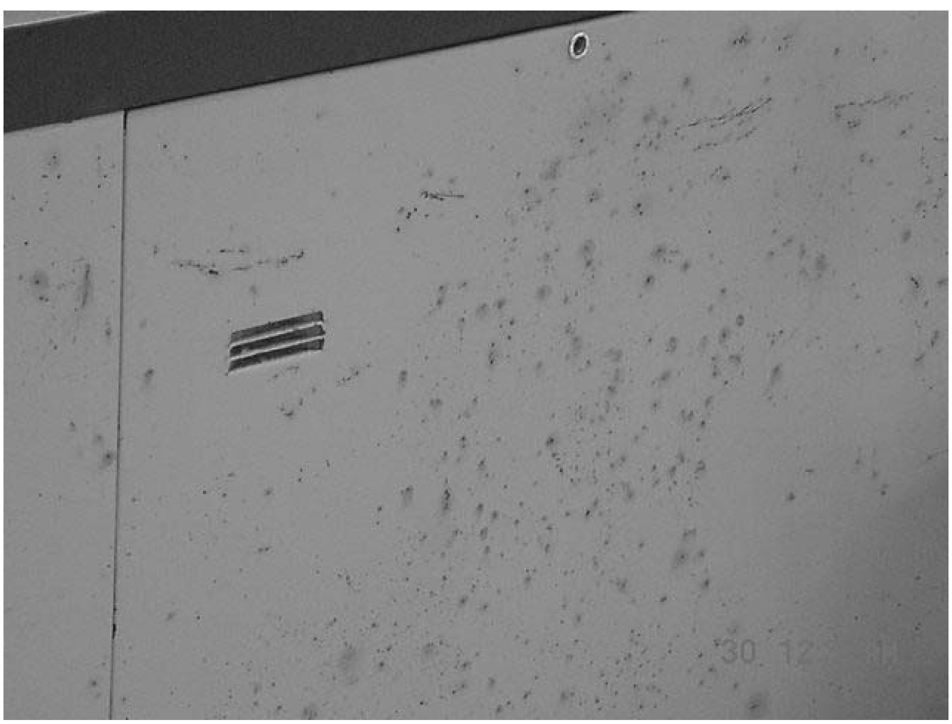
Picture 6

Ceiling-Mounted Exhaust Vent

Picture 7

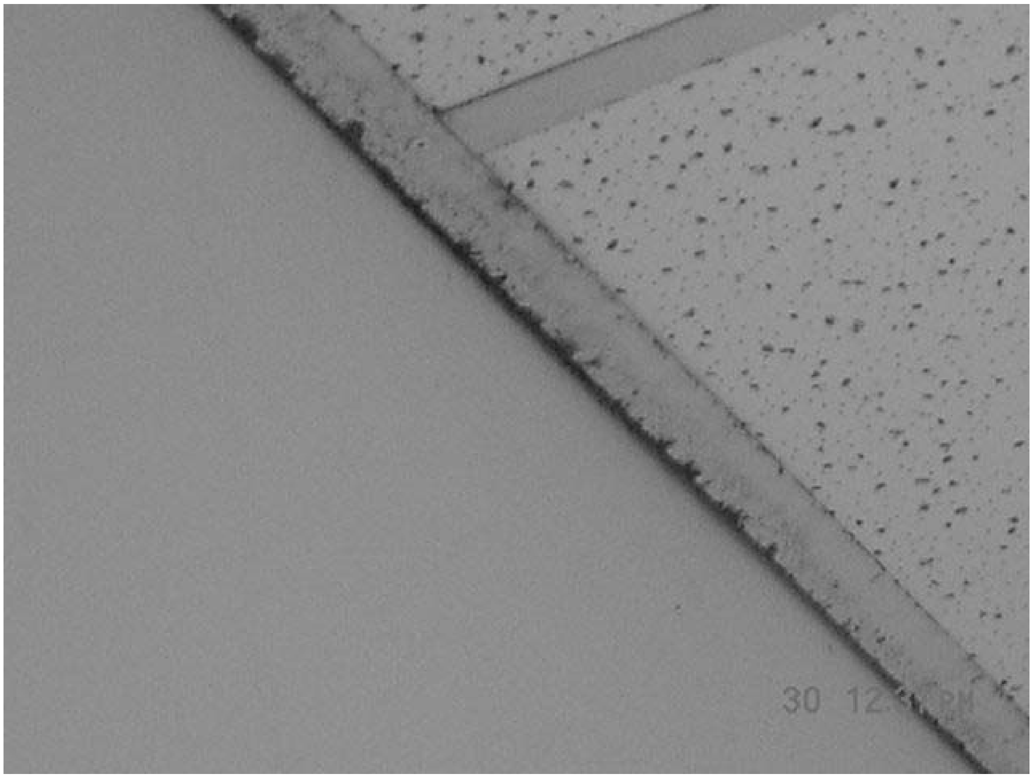
Rusted Bottom of File Cabinet Indicating Chronic Exposure to Moisture, Classroom 143

Picture 8



Rust Spots on Front Cover of Univent Cabinet Indicating Chronic Exposure to Moisture, Classroom 143

Picture 9



Rusted Bottom of File Cabinet Indicating Chronic Exposure to Moisture, Classroom 143

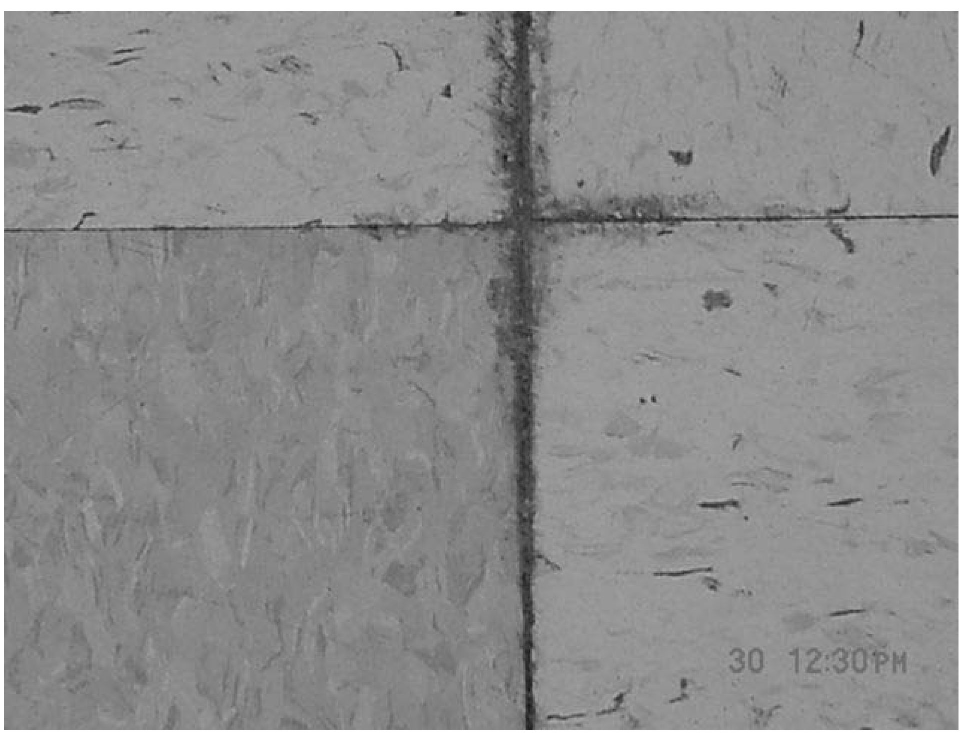
Picture 10

Peeling Paint in Classroom 143

Picture 11

Gum-Like/Mastic Material on/around Floor Tiles, Classroom 143

Picture 12

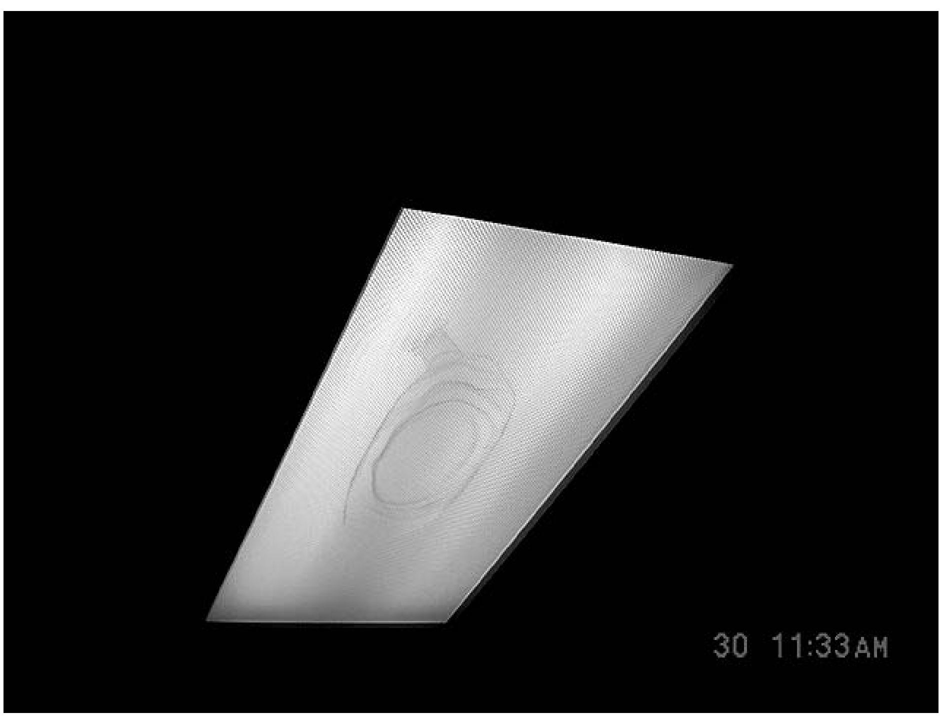


Close-Up of Gum-Like/Mastic Material on/around Floor Tiles, Classroom 143

Picture 13

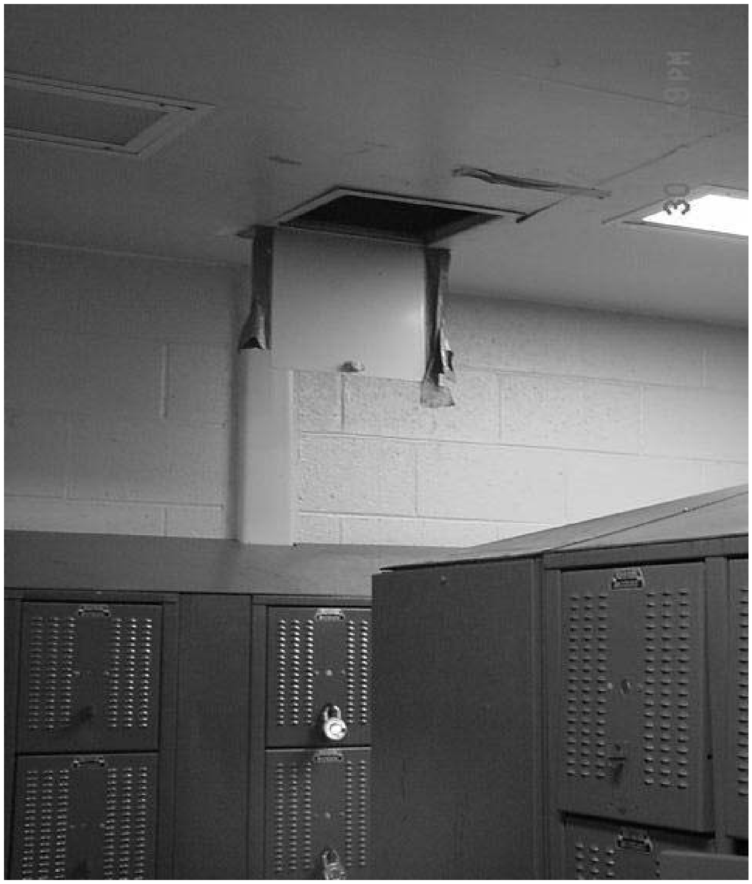
Water Damaged Ceiling Tiles

Picture 14



Water Damaged Lighting Panel in Room 250-B

Picture 15

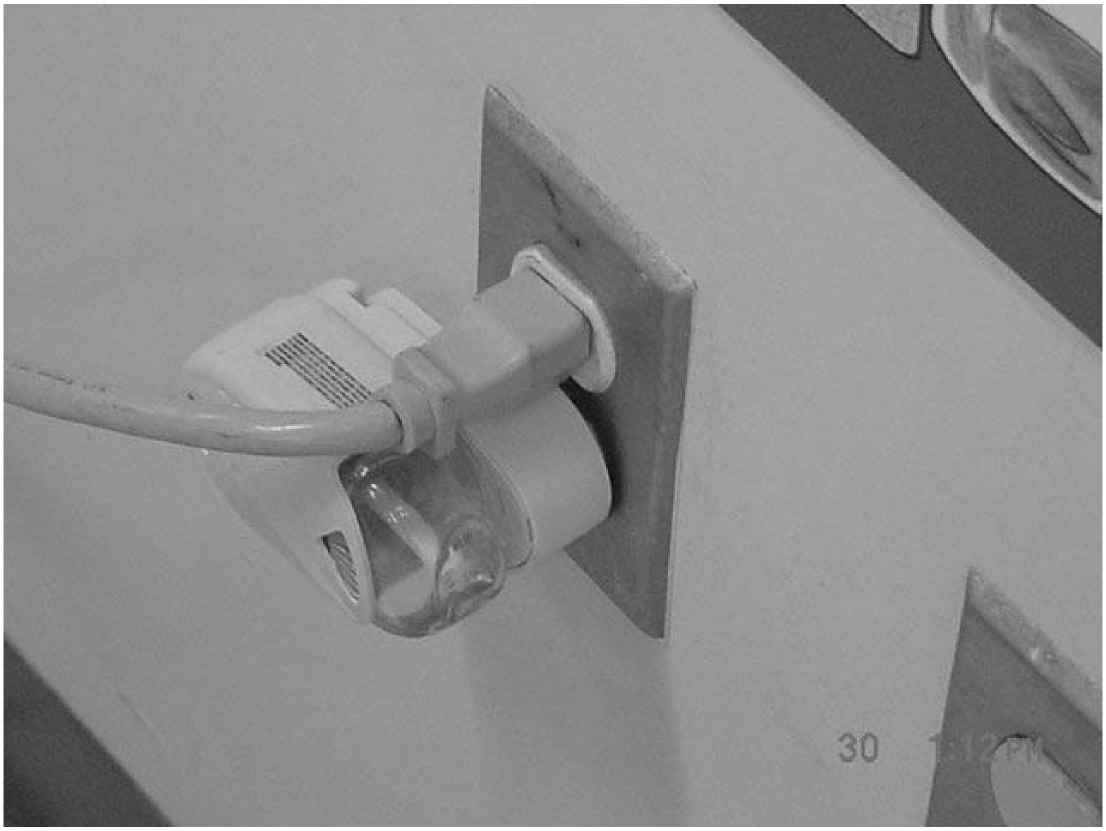


Active Ceiling Leak in Boy's Locker Room

Picture 16

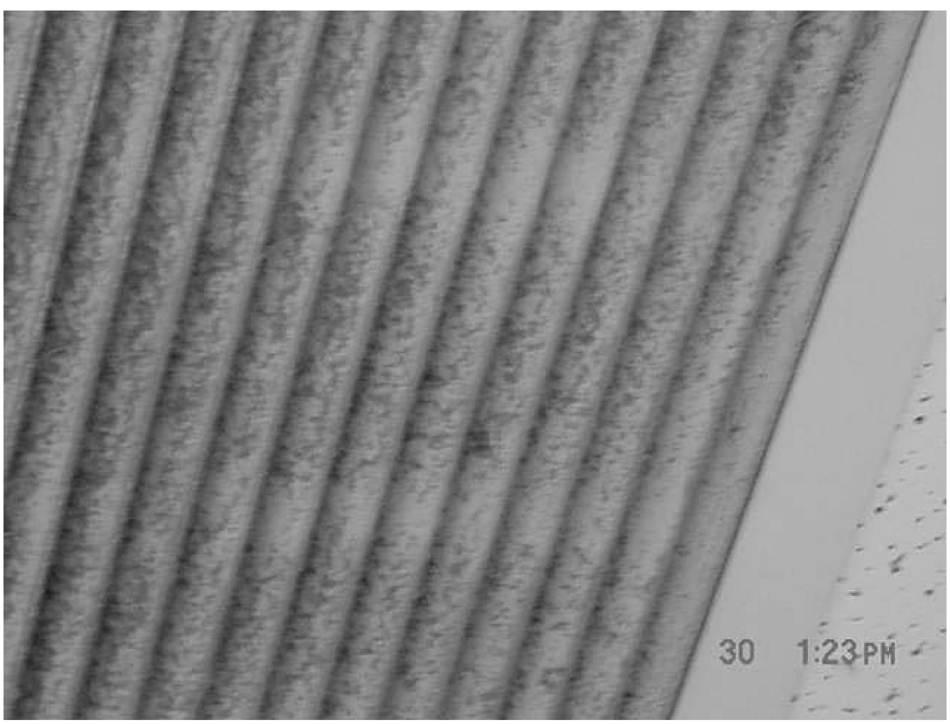
Plants on and around Classroom Univent

Picture 17



Plug-In Air Freshener in Classroom

Picture 18



Close-Up of Accumulated Dust on Exhaust Vent

Henry Lord Middle School | **Indoor Air Results**

151 Amity Street, Fall River, MA 02721 | **Date: 11/30/2005**

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
background	0	60	90	385	ND	ND	20	N			Moderate to heavy rain, winds SSE 10-15 mph, gusts up to 20 mph.
Boy's locker Room	0	68	65	825	ND	ND	14	N	Y ceiling	Y ceiling	Hallway DO, WD-ceiling, active roof leak .
cafeteria	200	71	64	941	ND	ND	19	N	Y ceiling	Y ceiling	Hallway DO,
gym	50	70	62	901	ND	ND	9	N	Y ceiling	Y ceiling	Hallway DO,
113	21	70	63	785	ND	ND	11	N	Y univent items	Y ceiling	#WD-CT: 1, DEM, bulging CTs.
114	26	71	62	1066	ND	ND	14	N	Y ceiling	Y ceiling	Hallway DO, DEM, items.
118	10	71	64	899	ND	ND	14	Y # open: 0 # total: 2	Y univent (off)	Y ceiling	DEM.

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium

AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials

design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile

NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings

sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Henry Lord Middle School

151 Amity Street, Fall River, MA 02721

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Date: 11/30/2005

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
119	21	71	65	902	ND	ND	9	Y # open: 0 # total: 2	Y univent items	Y ceiling	DEM, cleaners.
120	22	71	67	926	ND	ND	14	Y # open: 0 # total: 0	Y univent items	Y ceiling	Hallway DO, DEM.
123	24	69	68	644	ND	ND	10	Y # open: 0 # total: 2	Y univent	Y ceiling	DEM, UF, plants, peeling paint near windows.
130	22	69	60	792	ND	ND	11	N	Y univent (off)	Y ceiling	Hallway DO, DEM, items.
131	6	69	59	533	ND	ND	11	Y # open: 0 # total: 2	Y	Y ceiling	Hallway DO, DEM.
138	8	70	61	677	ND	ND	12	Y # open: 0 # total: 1	Y univent (off)	Y ceiling	Hallway DO, Inter-room DO, DEM.

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									Supply	Exhaust	
139	0	67	69	604	ND	ND	14	N	Y univent	Y ceiling	
143	2	68	68	599	ND	ND	7	Y # open: 0 # total: 2	Y univent	Y ceiling	Hallway DO, WD-ceiling, WD-non-porous material, DEM, chronic moisture issues-rusting on UV cover, ceiling tracks, file cab, peeling paint.
158	16	71	64	1041	ND	ND	12	Y # open: 0 # total: 2	Y univent (off)	Y ceiling	#WD-CT: 2, DEM.
160	20	70	65	756	ND	ND	11	Y # open: 0 # total: 2	Y univent plant(s)	Y ceiling	DEM, items.
201	29	74	61	981	ND	ND	13	Y # open: 2 # total: 2	Y ceiling	Y ceiling (off)	Hallway DO, DEM, broken CT.

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Indoor Air Results

Date: 11/30/2005

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
203	24	73	66	1112	ND	ND	18	Y # open: 0 # total: 2	Y ceiling	Y ceiling (off)	DEM.
204	2	70	68	603	ND	ND	18	Y # open: 0 # total: 4	Y univent	Y ceiling (off)	Hallway DO, #WD-CT: 1, DEM, 21 occupants gone approx 10 min.
205	1	71	64	620	ND	ND	12	Y # open: 0 # total: 3	Y	Y ceiling (off)	PC, plants, 10 occupants gone approx 30 mins, dust on ceiling tiles around supply vents.
210	10	74	58	643	ND	ND	7	N	Y ceiling	Y ceiling	DEM.
211	19	74	59	787	ND	ND	8	Y # open: 0 # total: 2	Y univent	Y ceiling	#WD-CT: 1, DEM.
212	16	75	57	930	ND	ND	15	Y # open: 0 # total: 2	Y (off)	Y ceiling	Hallway DO, DEM.

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
AP = air purifier
aqua. = aquarium

AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials

design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile

NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings

sci. chem. = science chemicals
TB = tennis balls
terra. = terrarium
UF = upholstered furniture
VL = vent location
WP = wall plaster

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Henry Lord Middle School

151 Amity Street, Fall River, MA 02721

Indoor Air Results

Date: 11/30/2005

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
213	8	74	57	733	ND	ND	12	Y # open: 0 # total: 2	Y univent (off)	Y ceiling	DEM, plants.
215	15	74	58	1010	ND	ND	20	Y # open: 0 # total: 2	Y univent (off)	Y ceiling	DEM, items, items hanging from CT.
216	10	72	61	795	ND	ND	16	Y # open: 1 # total: 2	Y univent (off)	Y ceiling	DEM.
220	25	74	61	1542	ND	ND	10	Y # open: 0 # total: 2	Y	Y ceiling	#WD-CT: 2, DEM.
222	26	72	59	798	ND	ND	10	Y # open: 0 # total: 2	Y univent	Y ceiling	DEM.
224	20	72	60	664	ND	ND	12	Y # open: 0 # total: 0	Y univent	Y ceiling	DEM.

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									Supply	Exhaust	
227	5	72	62	883	ND	ND	12	Y # open: 0 # total: 2	Y	Y ceiling	Hallway DO, DEM, 19 occupants gone approx 5 min.
228	0	72	61	773	ND	ND	10	Y # open: 0 # total: 2	Y univent	Y ceiling	Hallway DO, occupants at lunch.
234	22	71	62	841	ND	ND	13	Y # open: 0 # total: 0	Y univent furniture	Y ceiling	Hallway DO, DEM, plug-in.
235	13	71	61	629	ND	ND	13	N	Y univent	Y ceiling	Hallway DO, DEM, aqua/terra.
244	24	72	64	999	ND	ND	12	Y # open: 0 # total: 2	Y univent items	Y ceiling	DEM.
245	20	70	61	593	ND	ND	10	Y # open: 0 # total: 2	Y univent	Y ceiling	Hallway DO, DEM.

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									Supply	Exhaust	
246	17	72	61	918	ND	ND	11	Y # open: 0 # total: 2	Y univent	Y ceiling (off)	#WD-CT: 1, DEM, temperature complaints (cold).
250b	1	73	57	798	ND	ND	6	N	Y ceiling	Y ceiling (off)	#WD-CT: 4, DEM, water damaged lighting panel.

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